BARBER COLMAN

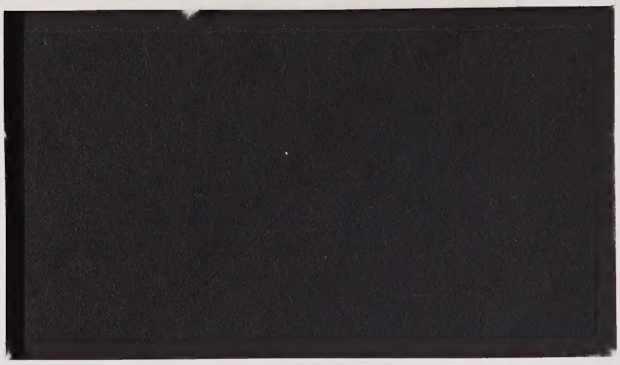
1412
IN 8

MODEL 622 SPL 11

POWER CONTROLLER

INSTRUCTION MANUAL

BARBER-COLMAN COMPANY
Industrial Instruments Div. • Rockford, Ill., U.S.A.



1412
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MODEL 622 SPL 11

POWER CONTROLLER

INTRODUCTION

The attached pages (preceding the yellow divider page) relate to the special Model 622 SPL 11 Power Controller and serve as difference data sheets to the standard Series 622 Power Controller instruction manual.

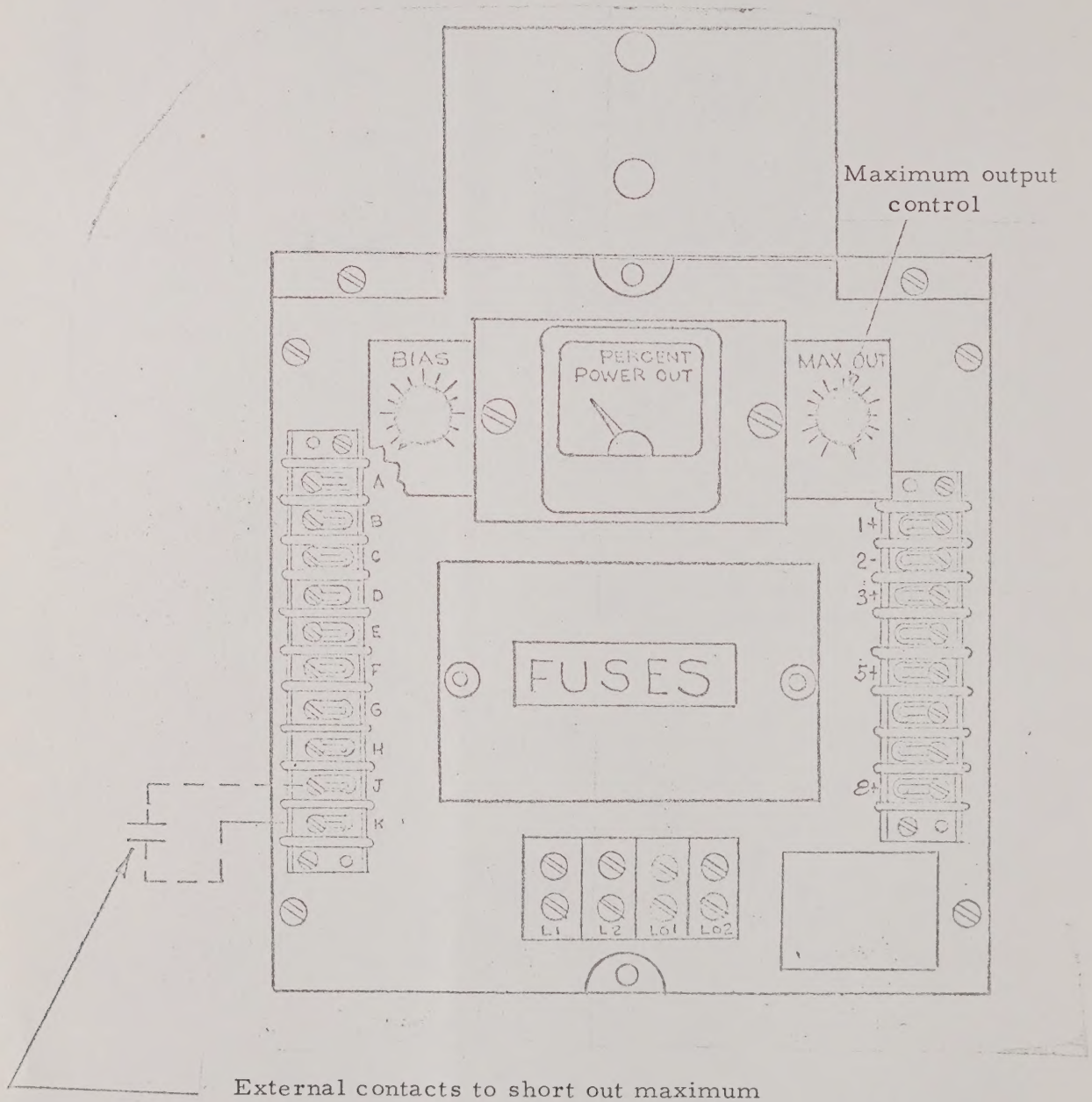
BARBER-COLMAN COMPANY
Industrial Instruments Division

Litho in U.S.A.

July 1966

MODEL 622 SPL 11

MAXIMUM POWER ADJUSTMENT



MODEL 622 SPL 11

This special Model 622 Power Controller, identified as the "SPL 11", incorporates additional circuitry to provide an adjustment for maximum output power. Refer to Figure 1 attached to this sheet for the wiring schematic. The maximum power adjustment is usable only on the 500 ohm, 1500 ohm and 5000 ohm input impedance. Operation of the 622 when using the 650 ohm input winding is not affected by the maximum output circuit.

Operation

Normal operation is obtained under the following conditions:

(a) Bias pot, fully CCW
(b) Maximum output pot, fully CCW

Advancing the maximum output pot CW reduces the maximum output voltage available, thus also reducing the maximum power for any given load. This circuit provides proportional control of the available power over the normal 10 ma span of the main control winding.

The bias control will decrease the control span, also affecting the maximum output. It is recommended that both bias and maximum output adjustments be made simultaneously to obtain the desired results.

The maximum turn-down, or minimum power, will be approximately 12-15% of rated load at line voltage.

Wiring

Power and control wiring is not affected.

Terminals J and K have been added to facilitate remote mounting of the maximum output pot. These terminals are also used to short out the maximum output circuitry for fast process heating times. At or before control point, the short is removed and the preset maximum power is available.

This fast heat-up control can be accomplished by cascading an SPL 11 Controller with a Barber-Colman proportional voltage or current output controller (e.g. 277P, 357A, 477P, 480P, MMC, MMP, TMC, or TMP) and a Barber-Colman 861A, 861A-1, or 861B Relay. (The 861A was previously known as the "03" Relay.)

All standard wiring is shown in the Model 622 instruction book. If desired, a jumper between terminals J and K will convert the unit into a standard controller with the maximum output pot rendered inoperable.

Segment of the Model 622 circuit altered in the SPL 11:

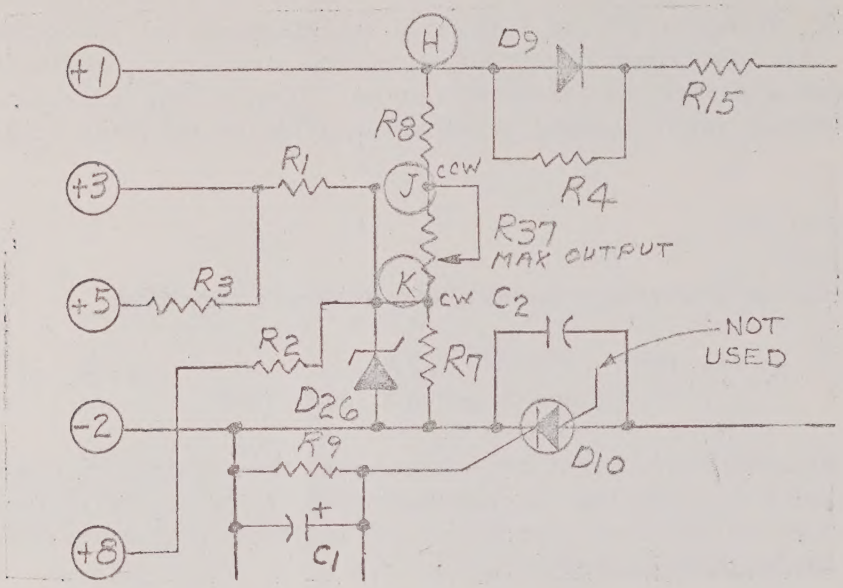


Figure 1

SPL 11 Addendum to Replacement Parts List of Model 622

Item	Part Number	Description
D26	31-21	5.7 v Zener Diode
R7	CYZR-170-32	470 Ω Resistor (changed from 330 Ω in normal 622)
R37	29-45	50 k Ω Potentiometer

The information on all other components in the SPL 11 can be found in the Schematic and Replacement Parts List in the Series 622 instruction manual, 1412 IN 3-2.

1412
IN 3-5

SERIES 622

POWER CONTROLLER

INTRODUCTION

This instruction manual is designed to help you secure maximum benefits from your new Model 622 Power Controller. It should be given to persons responsible for installation, operation and maintenance of this instrument.

Your Barber-Colman factory trained field engineer is always available for further help in the solution of your control problems. Offices are located in all principal cities.

BARBER-COLMAN COMPANY
Industrial Instruments Division

Litho in U.S.A.

December 1967

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MATERIAL WARRANTY

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge if returned prepaid to the Factory at Rockford, Illinois.

1412 IN 3
Rev. 12-67

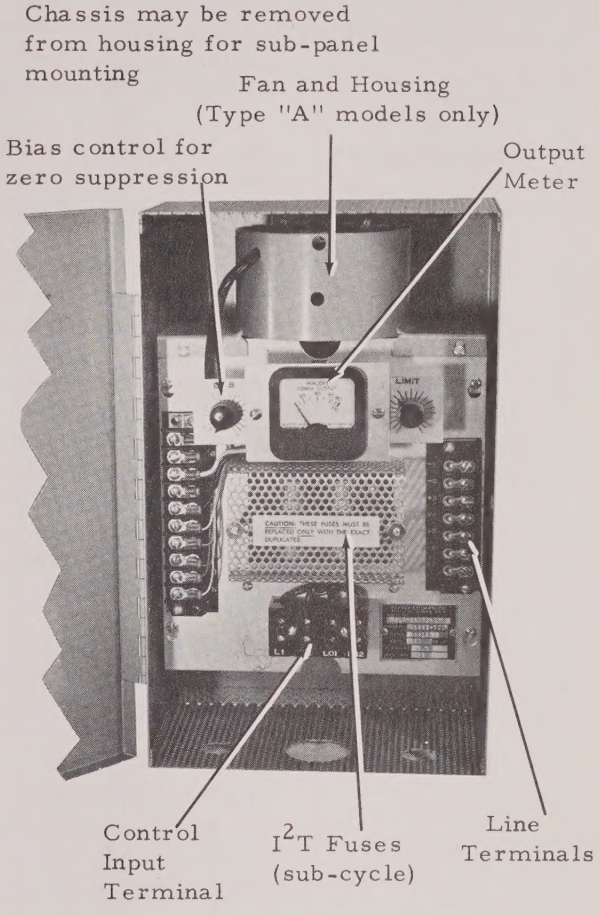
DESCRIPTION

The 622 Power Controller is an all solid state device, using silicon controlled rectifiers to proportion a-c power to a load in direct relation to a small d-c control signal.

Prior to the development of the silicon controlled rectifier, the proportioning of power to a furnace or other electrical load required the use of a saturable core reactor and pilot amplifier or a variable transformer. In a high percentage of these applications, the Series 622 can be used as a direct replacement for a saturable reactor/pilot amplifier combination. It possesses the advantages of less weight and space, no load matching problems (assuming the controller kva rating is sufficient), operation is continuous from full ON to full OFF, and the response time is many times faster. Response of a saturable core reactor is usually measured in seconds, while the response of the 622 Power Controller is in milliseconds.

Power is controlled by two silicon controlled rectifiers (SCRs) which are capable of blocking the flow of current until pulsed by a grid (or gate) signal, after which conduction is continuous until the anode voltage is interrupted. The SCRs are arranged in a back-to-back configuration so that conduction to the load may take place in each half cycle of the full wave a-c power supply. The control circuitry for the firing of the SCRs incorporates a magnetic amplifier through which the input control signal acts to advance or retard the phase angle at which the SCRs are made to conduct. The affect is an OFF-ON proportioning within each half cycle, such that the amount of ON time (as a function of the phase angle) is determined by the magnitude of the d-c output from a primary or intermediate controller. This results in a linear power transfer characteristic.

The Series 622 is designed to receive its control input signal from a Barber-Colman millivoltmeter or potentiometer with proportional current controller. An alternate choice of control terminals provide for an input signal of the level used by other instrument manufacturers. The Series 622 is equipped with a bias control for "zero suppression" so that it may be made to operate through different ranges of control inputs. This feature enables several power


Chassis may be removed from housing for sub-panel mounting
Fan and Housing (Type "A" models only)
Bias control for zero suppression
Output Meter
LIMIT
Control Input Terminal
I²T Fuses (sub-cycle)
Line Terminals

Series 622 Power Controller

controllers, in tandem, to be driven from a central control. Further explanation of this application is found in the section under "Bias Control".

A slow start or magnetization control enables the Series 622 to drive transformer coupled loads without difficulty. This feature has overcome the problem of early designs of silicon controlled rectifier power controllers which encountered problems related to the magnetization of the transformer core.

Usage of the 622 Power Controller is limited to resistive or transformer coupled resistive loads that have a maximum resistance change of 1.15 to 1. Furnaces using platinum or molybdenum heating elements undergo a much greater resistance change with change in temperature. For these applications, the Series 621 Power Controller, which provides current limiting, is recommended.

SPECIFICATIONS AND OPERATING CHARACTERISTICS

Power Ratings: (60 cycle standard; 50 cycle available)

Ratings to 7.5 kva at 120 volts
Ratings to 13.0 kva at 208 volts
Ratings to 15.0 kva at 240 volts
Ratings to 17.3 kva at 277 volts
Ratings to 30.0 kva at 480 volts

Load Requirements:

Any resistive or transformer coupled resistive load having no more than a 1.15 to 1 resistance change can be driven by the 622 Power Controller.

Matching of the load kva to the controller (as required when using saturable core reactors) is not necessary. The only requirement is to have the load kva at line voltage within the power rating of the 622 Controller. A 15 kva unit will steplessly proportion and control power to a 100 va load equally as well as it will to a 15 kva load.

Inrush or Slow Start Feature:

The 622 Power Controllers have a built-in inrush or slow start circuitry. This feature limits inrush currents at start-up and permits the power controller to be used with auto transformers, variable auto transformers (Powerstats, Variacs) or high inrush isolation transformers. No special start-up procedures or auxiliary equipment are needed.

Power Rating with Increased Ambient Temperatures:

All 622 Controllers are rated to deliver full nameplate kva ratings at an ambient temperature of 130°F. No derating of power output is required at any temperature in the ambient operating range of 40°F to 130°F.

Control Input:

One control winding is provided with a choice of either 10 ma or 5 ma span. Input impedances of 500 ohms, 1500 ohms, or 5500 ohms obtainable with the 10 ma span. The 5 ma span has an input impedance of 650 ohms.

Bias Control:

Used for zero suppression, bias control may be used to suppress up to the maximum rated control span, that is, 0-10 ma of the 10 ma input, or 0-5 ma of the 5 ma input.

All Solid State Circuitry:

All components of the 622 Controller are solid state. All control functions are accomplished without the use of relay or vacuum tubes.

Component Protection:

1) To prevent sub-cycle faults from damaging the silicon controlled rectifiers, two special I^2T fuses are used. These fuses are not for overload or over current protection of the controller or the load.

2) To prevent transient voltage spikes from damaging the silicon controlled rectifiers, a transient voltage protector is placed across them. The protector provides a short-circuit path for transient voltages that are in excess of the SCR voltage rating.

Mounting:

All units must be mounted vertically for either natural or forced air convection cooling. In any model, the chassis can be removed from its housing for sub-panel mounting. The fan for forced convection cooling is part of an assembly attached to the main chassis.

Dimensions:

Case dimensions of the natural convection units (Model 622B) are 11 3/8" high x 8 7/16" wide x 5 3/8" deep.

Case dimensions of the forced air cooling units (Model 622A) are 13 7/8" high x 8/7/16" wide x 5 3/8" deep.

MODELS AVAILABLE AND RATINGS

622 Series Model Number**	SINGLE PHASE Maximum Ratings at given Line Volts				*THREE PHASE Maximum Ratings at given Line Volts (balanced)				
	KVA Rating	Line Volts	Load Amps	Reference Figure 3 Diagram No.	Phase KVA	Line Volts	Phase Volts	Phase Amps	Reference Figure 3 Diagram No.
622B-12060-024	2.4	120	20.0	1	7.2	208	120	20.0	4
622A-12060-034	3.4	120	28.0	1	10.2	208	120	28.0	4
622A-12060-075	7.5	120	62.5	1	22.5	208	120	62.5	4
622B-20860-021	2.1	208	10.0	1	6.3	208	208	10.0	2 or 3
622A-20860-031	3.1	208	15.0	1	9.3	208	208	15.0	2 or 3
622B-20860-042	4.2	208	20.0	1	12.6	208	208	20.0	2 or 3
622A-20860-058	5.8	208	28.0	1	17.4	208	208	28.0	2 or 3
622A-20860-130	13.0	208	62.5	1	39.0	208	208	62.5	2 or 3
622B-24060-024	2.4	240	10.0	1	7.2	240	240	10.0	2 or 3
622A-24060-036	3.6	240	15.0	1	10.8	240	240	15.0	2 or 3
622B-24060-048	4.8	240	20.0	1	14.4	240	240	20.0	2 or 3
622A-24060-067	6.7	240	28.0	1	20.1	240	240	28.0	2 or 3
622A-24060-150	15.0	240	62.5	1	45.0	240	240	62.5	2 or 3
622B-48060-048	4.8	480	10.0	1	14.4	480	480	10.0	2 or 3
622A-48060-072	7.2	480	15.0	1	21.6	480	480	15.0	2 or 3
622B-48060-096	9.6	480	20.0	1	28.8	480	480	20.0	2 or 3
622A-48060-134	13.4	480	28.0	1	40.2	480	480	28.0	2 or 3
622A-48060-300	30.0	480	62.5	1	90.0	480	480	62.5	2 or 3
622B-27760-028	- -	- -	- -	-	8.4	480	277	10.0	4
622A-27760-042	- -	- -	- -	-	12.6	480	277	15.0	4
622B-27760-055	- -	- -	- -	-	16.5	480	277	20.0	4
622A-27760-078	- -	- -	- -	-	23.4	480	277	28.0	4
622A-27760-173	- -	- -	- -	-	51.9	480	277	62.5	4

*Three units required on all three phase systems.
**50 cycle units available upon request.
Note: All ratings based on a maximum ambient temperature of 130°F.

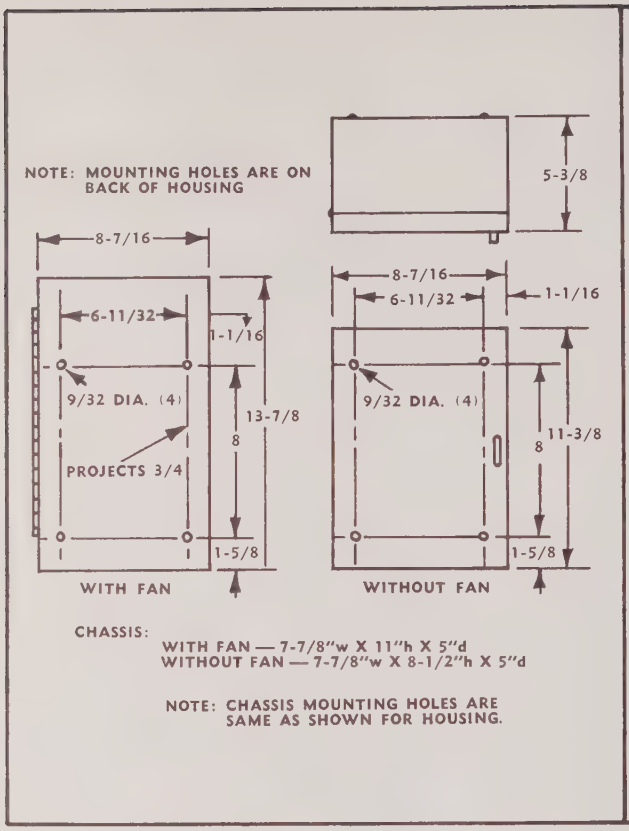


Figure 1
Mounting Dimensions

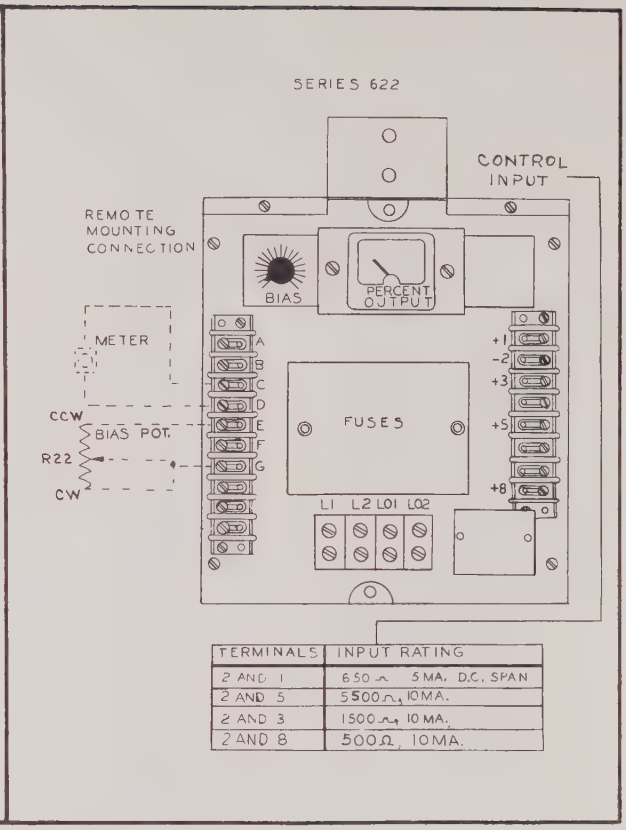


Figure 2
Remote Mounting Connections

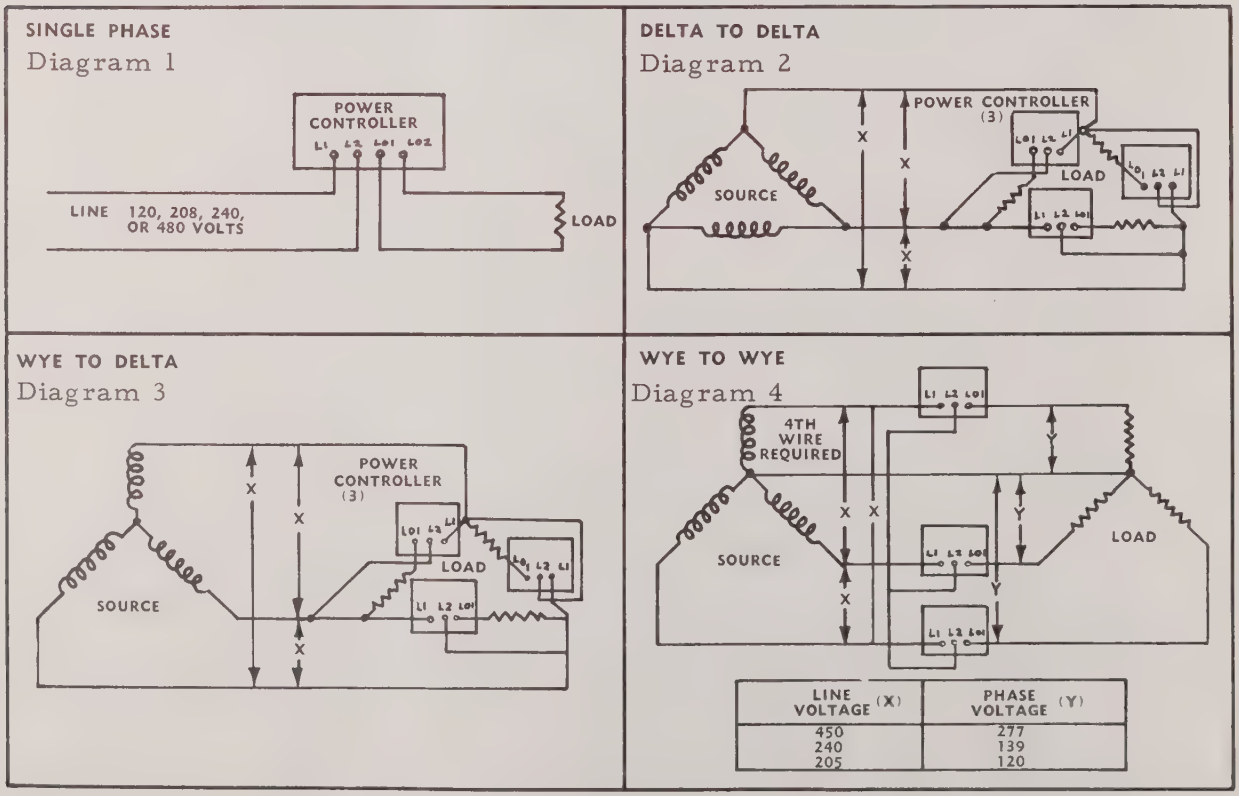


Figure 3 - Control Wiring

Mounting

Both the fan cooled and natural convection units must be mounted in a vertical position. See Figure 1 for mounting dimensions.

Remote mounting of the output meter or bias control potentiometer can be easily accomplished. The meter and potentiometer are mounted on a detachable bracket and the wiring to these devices is done through a separate terminal board mounted on the front of the 622 control chassis. The terminals of this board are identified by letters. Terminals E, F and G are the connections for the bias control potentiometer; terminals C and D are the connections for the output meter and its calibrating resistor.

Refer to Figure 2 for location of terminals used when remote mounting the control or meter.

Location

The 622 Series Power Controller must be located in areas where it is known that the ambient temperature will not exceed 130°F. The area of location must not have high concentrations of lint or dust. Areas where the moisture content of the air is known to be unusually high should be avoided.

Wiring

Connect power wiring with stranded wire, sized in accordance with national and local codes. Use knockout access holes provided in bottom and sides of the case.

Control wiring can be 16 or 18 gauge wire from the controlling instrument. Do not run power wiring and control circuit wiring in the same conduit or wiring trough.

Control Inputs

The control winding of the Series 622 is designed for a choice of input impedance and span by terminal selection. Terminals 2 and 5 provide for a span of 10 ma and an input impedance of 5500 ohms, which is the proper load impedance for Barber-Colman's Model 407P and MMC control instruments. Terminals 2 and 3 provide a span of 10 ma and an input impedance of 1500 ohms, which is the proper load impedance for Barber-Colman's Models 277P, 357P, 354P, 477P, and MC control instruments. A 5 ma span with an input impedance of 650 ohms is provided for use with other controllers by wiring to terminals 1 and 2. Terminals 2 and 8 provide an input impedance of 500 ohms. They are used mainly in applications where three Series 621 Controllers are driven with one Model 277P, 354P, 357P, 477P or MC. The control windings are wired in series.

Three Phase Installation

Design of the Power Controller is such that certain restrictions are necessary for applications in three phase systems. They may be used in any Delta system providing placement is made inside the Delta and not in the line. They are capable of being used in a Wye system only if the three phase power source is also from a Wye and is four-wire. Acceptable wiring arrangements for three phase operation are shown in Figure 3.

In any three phase application, care must be taken in installation for they are not directly interchangeable with saturable core reactors. Reactors can be used in any three phase system by inserting directly into the line as long as their rating is properly selected.

For typical external wiring diagrams,
see pages 12, 13, and 14.

Inrush Limiting or Slow Start Feature

In order to present a simplified explanation of the device, a drawing showing the various functional blocks is shown in Figure 4.

Though the actual circuitry is more complex than indicated by this diagram, basic principles of operation can be more readily understood.

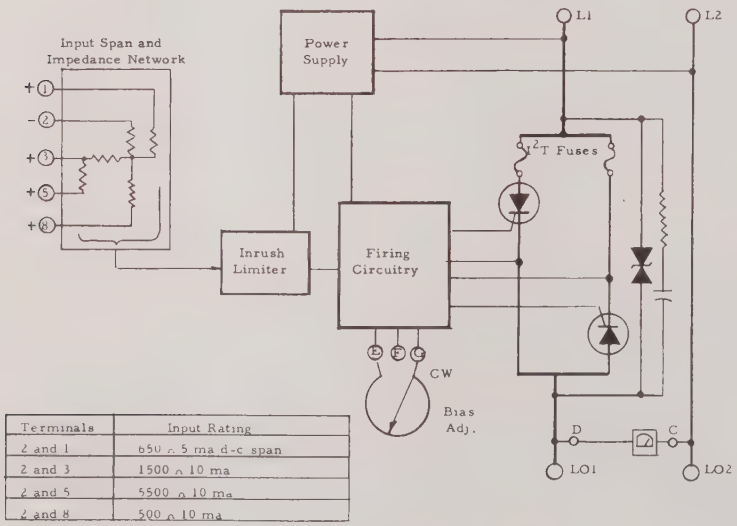
All power, other than the d-c input control signal, is derived from the power source. Because the same power source feeds both the firing circuitry and the main power control section, the operation of these sections is closely interlocked.

The sequence of operation and the interlocking of the 622 circuitry is as follows:

With no voltage applied to L1 and L2 of the 622, there is no output of the firing circuitry, even though there may be an input control signal present at the control winding.

When line voltage is applied to L1 and L2, a 200 millisecond delay is initiated before the firing circuitry can function.

At the end of the 200 millisecond delay, the inrush circuitry allows the firing circuitry to gate the SCRs. The gating of the SCRs is started at a very small conduction angle and is gradually increased. Starting with a very small conduction angle, very low voltage is applied to the load circuit. This prevents saturation of any transformers in the load circuit and permits dependable turn-on with transformer coupled loads.



Terminals	Input Rating
2 and 1	650 ∩ 5 ma d-c span
2 and 3	1500 ∩ 10 ma
2 and 5	5500 ∩ 10 ma
2 and 8	500 ∩ 10 ma

Figure 4
Series 622 Block Diagram

Line Voltage Effects

The power transfer curve, Figure 5 shows the rated percent of output power for a given control current. Actual percent of output will vary due to fluctuations of line voltage. The extremes of this situation are shown by the curves in Figure 6. In many applications, particularly those operating near mid-range of output power, this presents no problem. Where the degree of control required is such that this variation cannot be tolerated, the Barber-Colman Series 621 should be specified. Using built-in voltage compensation, the Series 621 output will remain within ±1.5% for a ±10% line voltage change.

Bias Control

The "zero suppression" ability of the bias control may be utilized to move the operating range into the linear portion of the Model MC or any of the Barber-Colman proportional current output millivoltmeter controllers (Models 407P, 477P, 277P, 357P and 354P). With the normal operating control span of these devices from 2 to 12 ma, suppression may be introduced to "chop off" the 2 ma lower portion of the output curve which, in narrow proportional bands, may be quite irregular. Thus, with a Model 407P control, for an example, the Power Controller may be made to "turn on" at 2 ma and reach full ON at 12 ma of straight line control input current. See Figure 7.

Zero suppression is also used advantageously for tandem systems in which several zones of a furnace may be made to operate at different current inputs as directed from a central point of measurement. For example, one controlling instrument, receiving its signal from the central zone of a furnace, may be used to drive three series connected power controllers with each biased to operate through a different range of control input. This is illustrated in Figure 12. In this example, a control current of, say, 7 ma may be flowing to the control windings of each of the Series 622s. At this instant there could be approximately 65% power output at zone B (4 ma suppression) and 15% at zone C (4 ma suppression). Such a system is employed to give a balanced heating throughout the length of a furnace.

Replacing Blown I^2T Fuses

a. Using an ohmmeter, determine which fuse has blown.

b. The correct replacement I^2T fuse must be used. This fuse is not an overload protective device and is used only to protect the SCR against rapid rising current (Di/Dj). SCR failures will result from use of wrong type fuses. The fuse listed in the Instruction Manual is the only one that should be used. If a fuse from another manufacturer is considered, check to make sure it is an equivalent type; there are different type I^2T fuses.

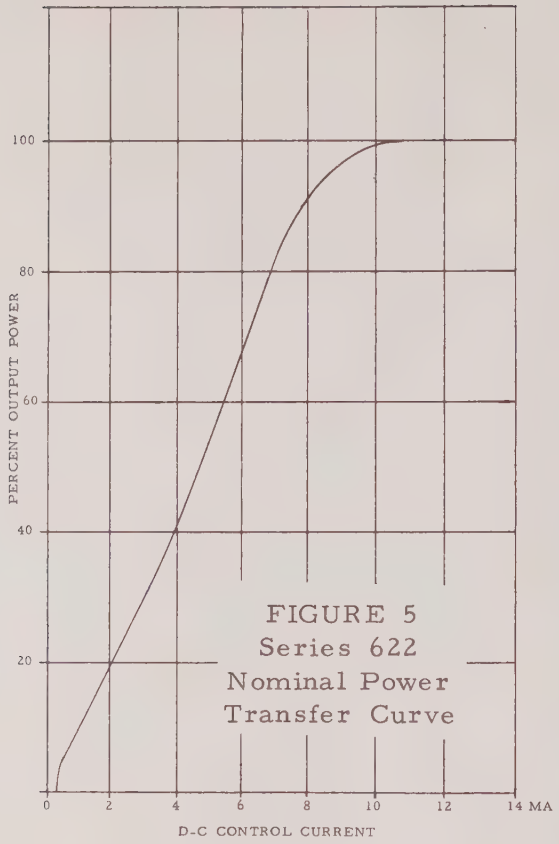


FIGURE 5
Series 622
Nominal Power
Transfer Curve

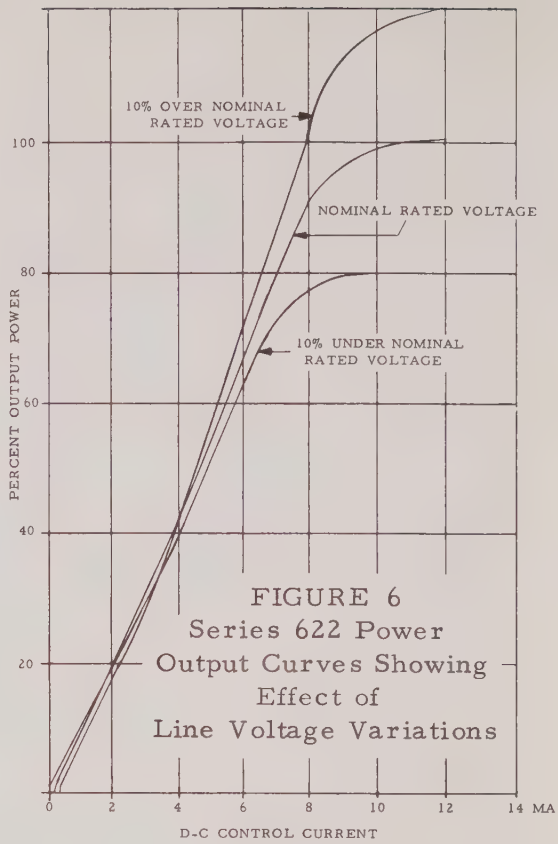


FIGURE 6
Series 622 Power
Output Curves Showing
Effect of
Line Voltage Variations

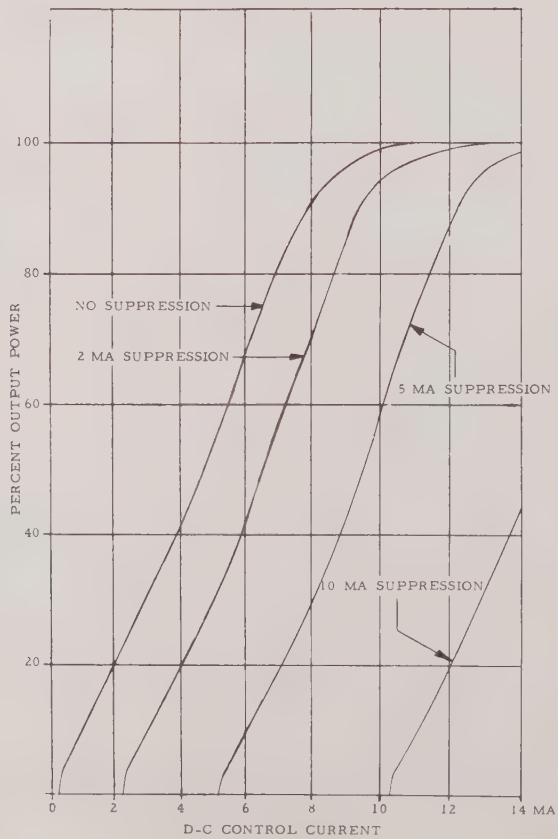


FIGURE 7
Series 622
Power Output
Curves Showing
Effect of Dual
Adjustment
(output suppression)

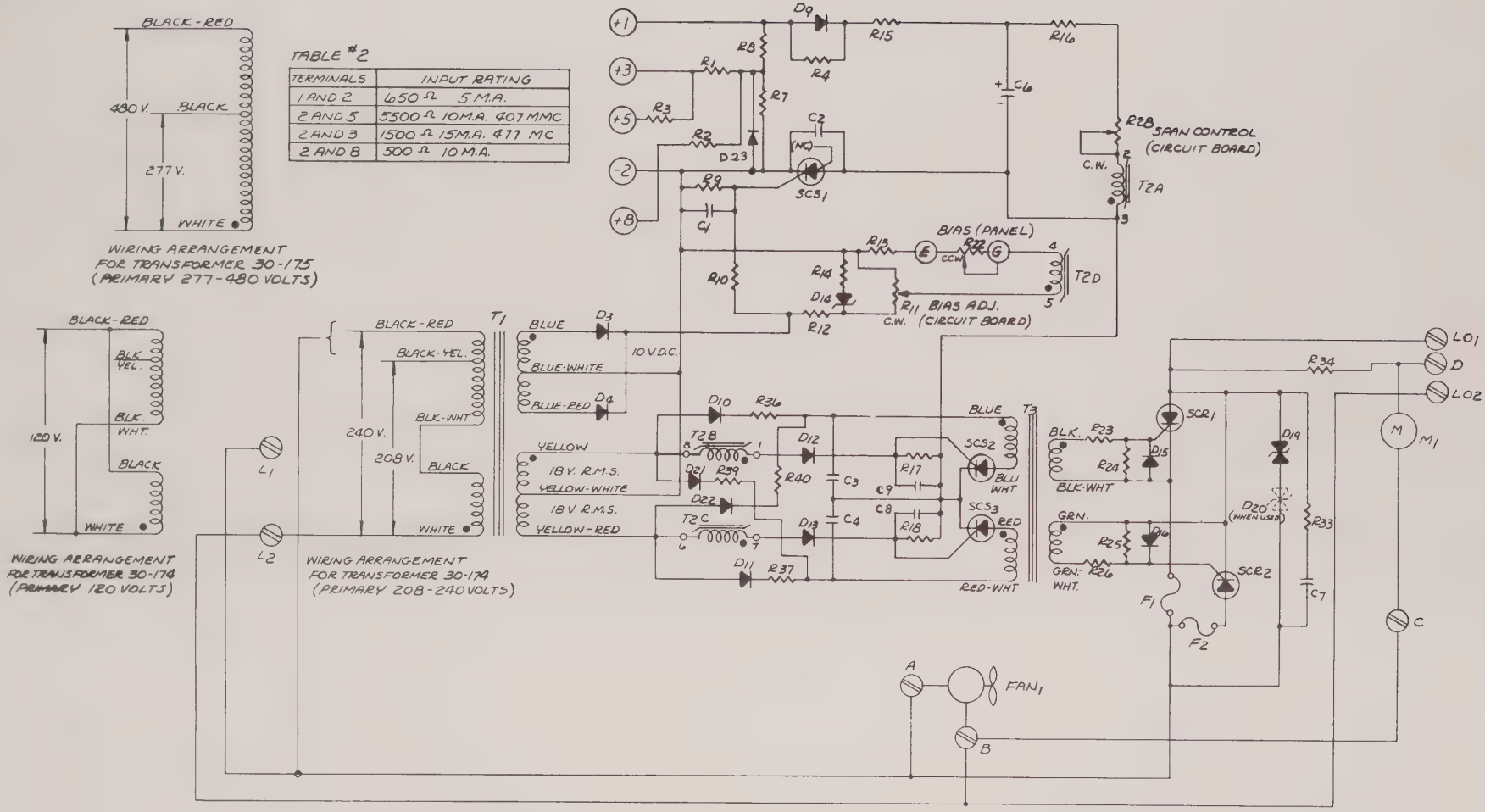


FIGURE 8

SERIES 622 INTERNAL WIRING DIAGRAM
(applies to instruments with approximate starting serial number 76K)

PARTS LIST - SERIES 622

Item	Part Number	Description
C1	CYZR-663-1	125 mfd +100 -10% 3 vdcw Capacitor
C2	39-103	.01 mfd 500 vdcw Capacitor
C4, C5	39-77	2 mfd 200 vdcw +40 -20% Capacitor
C6	39-200	60 mfd ± 20% 75 vdcw Capacitor
C7	See Table II	.5 mfd ± 20% Capacitor
C8, C9	39-62	.02 mfd 600 vdcw Capacitor
D3, D4 D12, D13 D15, D16 D21, D22 D23	EYZP-384	Silicon Diode 80 piv 100 ma
D9	37-13	Germanium Diode (IN91)
D10, D11	37-66	Silicon Diode 500 piv 700 ma
D14	31-37	Zener Diode 3.9 v ± 10% 400 mw (IN748)
D19	See Table III	Surge Protector
F1, F2	See Table III	Fuse
Fan 1	See Table III	Fan Assembly
M1	50-203	Meter
R1	CYZR-17-23	1.2K Ω ± 10% 1/2 w Resistor
R2	CYZR-170-56	180 Ω ± 10% 1/2 w Resistor
R3	CYZR-326-93	3.9K Ω ± 1% 3 w Resistor
R4, R10	CYZR-170-45	15K Ω ± 10% 1/2 w Resistor
R7, R8	CYZR-170-47	330 Ω ± 10% 1/2 w Resistor
R9, R39, R40	CYZR-133-2	1.5K Ω ± 5% 1/2 w Resistor
R11	CYZR-158-3	500 Ω ± 20% 2 w Pot
R12	CYZR-170-27	100 Ω ± 10% 1/2 w Resistor
R13	CYZR-170-28	220 Ω ± 10% 1/2 w Resistor
R14	CYZR-170-57	18 Ω ± 10% 1/2 w Resistor
R15	CYZR-170-22	1K Ω ± 10% 1/2 w Resistor
R16	40-62	1.2 Ω ± 10% 1/2 w Resistor
R17, R18	CYZR-682-2	56 Ω ± 10% 1/2 w Resistor
R22	BYZR-22-2	300 Ω ± 20% 2 w Pot
R23, R26	40-78	15 Ω ± 10% 1/2 w Resistor
R24, R25	CYZR-170-31	33 Ω ± 10% 1/2 w Resistor
R28	BYZR-93-4	15K Ω ± 20% 2 w Pot
R33	See Table II	Non-Inductive Resistor
R34	See Table I	Meter Multiplier Resistor
R36, R37	40-335	33 Ω ± 10% 1 w Resistor
SCR1, SCR2	See Table III	Silicon Controlled Rectifier
SCS1	37-94	Silicon Controlled Switch V_{bo} = 50 1.6 amp
SCS2, SCS3	37-59	Silicon Controlled Switch 50 piv 200 ma
T1	30-174	Power Transformer
T1	30-175	Power Transformer (277 and 480 volt only)
T2	30-172	Magnetic Amplifier (50/60 cycle)
T3	30-173	Pulse Transformer (50/60 cycle)

TABLE I
METER MULTIPLIERS

Volts	R34	Description
120	CYZR-326-86	1500 Ω ± 1% 3 w
208	40-199	7500 Ω ± 1% 3 w
240	CYZR-326-44	10K Ω ± 1% 3 w
277	40-246	13K Ω ± 1% 3 w
480	40-278	27K Ω ± 1% 10 w

TABLE II

Voltage	C7 dv/dt Capacitor	R33 Non-Inductive dv/dt Resistor
120 v	CYZR-423 .05 mfd (600 vdcw)	40-266 (22 ohm, 2 watt)
208 v 240 v 277 v		40-284 (25 ohm, 7 watt)
480 v	39-218 .05 mfd (480 vacw)	40-285 (45 ohm, 25 watt)

TABLE III

Voltage	KVA Rating	Chassis Assembly Number (60 cycle)	Fan Assembly	SCR	Surge Protector (D19 or D20)	Fuse F1 and F2
208	4.2	A-6058-200	None	37-31 (2N688)	37-34*	50-204 20 amps (Amptrap A25x20)
	5.8	A-6058-300	A-5898-200			
240	4.8	A-6058-400	None			
	6.7	A-6058-500	A-5898-300			
120	2.4	A-6059	None	37-32-2 (2N685)	37-33**	
	3.4	A-6059-100	A-5898			
208	2.1	A-6060	None	37-37 (2N1849)	37-34*	50-208 10 amps (Amptrap A25x10)
	3.1	A-6060-100	A-5898-200			
240	2.4	A-6060-200	None			
	3.6	A-6060-300	A-5898-300			
277	2.8	A-6061	None	37-47 (2N1850)		
	4.2	A-6061-100	A-5898-400			
	5.5	A-6062	None	37-48 (2N689)		50-204 20 amps
	7.8	A-6062-100	A-5898-400			
	17.3	A-6062-201	A-5898-400	37-158 37-78‡		50-235 50 amps
120	7.5	A-6063-1	A-5898	37-159 37-56‡	37-33**	
208	13.0	A-6064-1	A-5898-200	37-152 37-57‡	37-34*	
240	15.0	A-6064-101	A-5898-300			
480	4.8	A-6169	None	37-83 (W202S)	37-34* (2 req'd)	50-208 10 amps
	7.2	A-6169-100	A-5898-500			
	9.6	A-6170	None	37-84 (W201S)		50-204 20 amps
	13.4	A-6170-100	A-5898-300			
	30.0	A-6171-1		37-153 37-85‡		50-235 50 amps

‡Used for models built prior to starting serial number 76K (approximate).
*GE# 6RS21SA11D11
**GE# 6RS21SA6D6

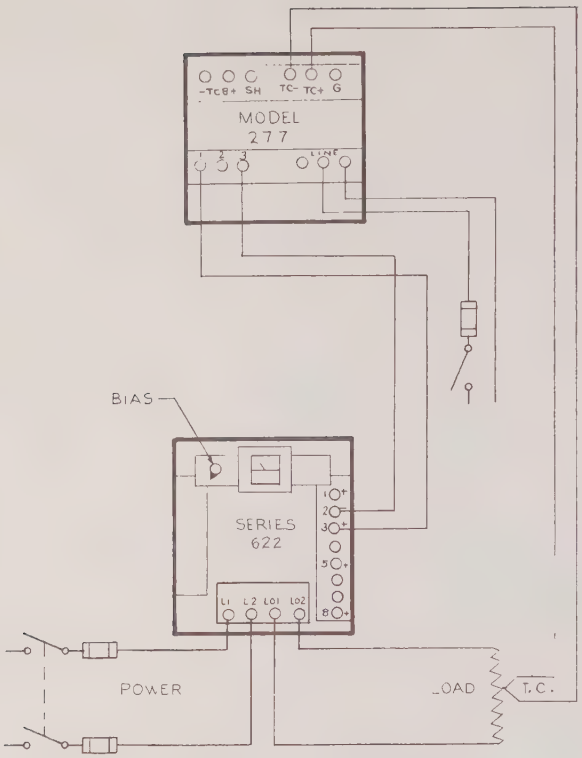


Figure 9
External Wiring Diagram
Series 622 with Model 277P Capacitrol

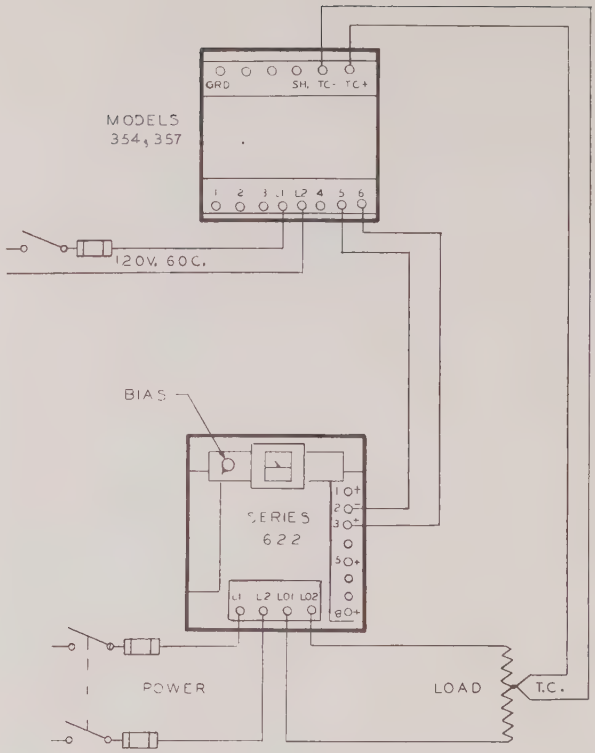


Figure 10
External Wiring Diagram
Series 622 with Models 354 or 357 Digiset

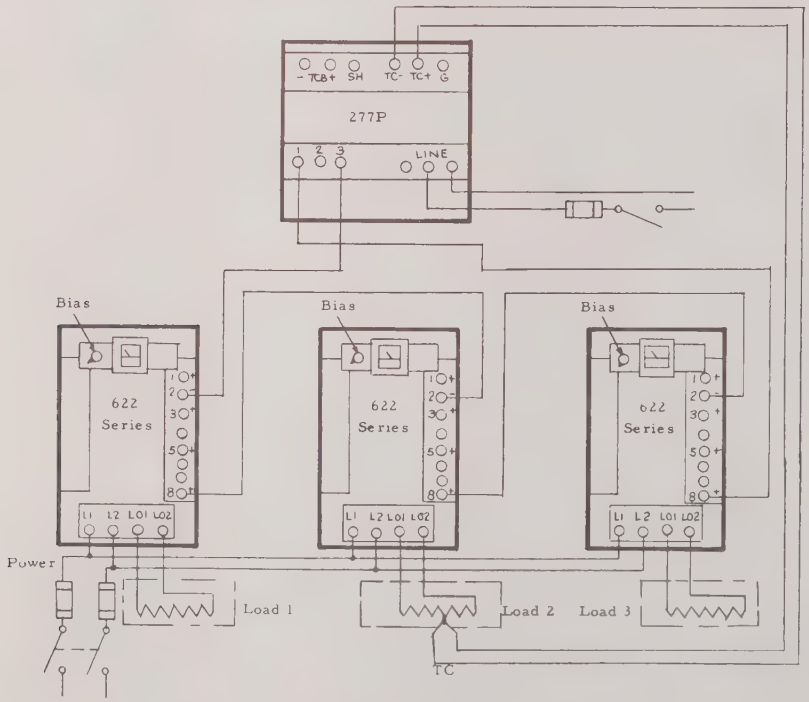


Figure 11
External Wiring Diagram
Model 277P Capacitrol Driving Three 622 Controllers for Three Zone Control

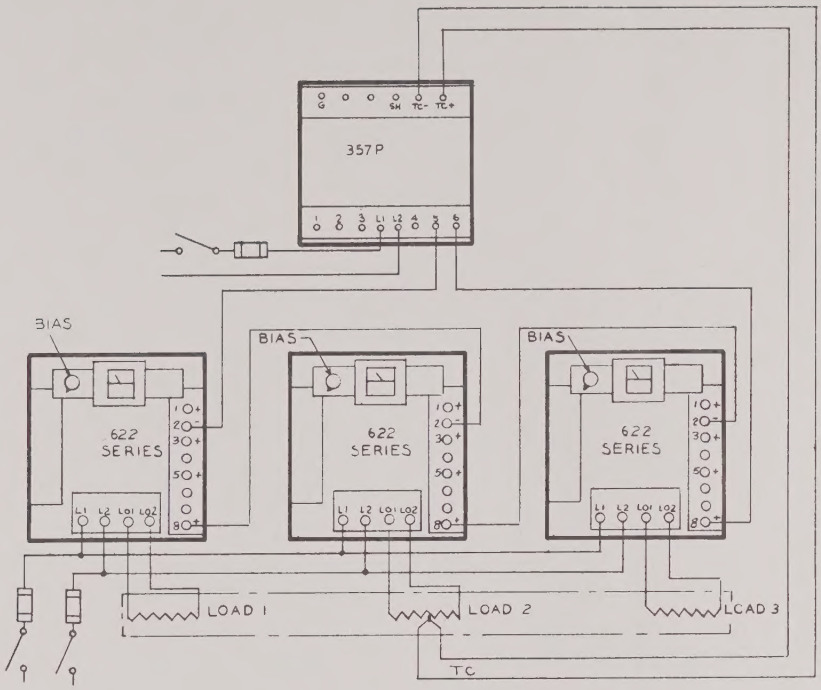


Figure 12
External Wiring Diagram
Model 357P Digiset Driving Three 622 Controllers for Three Zone Control

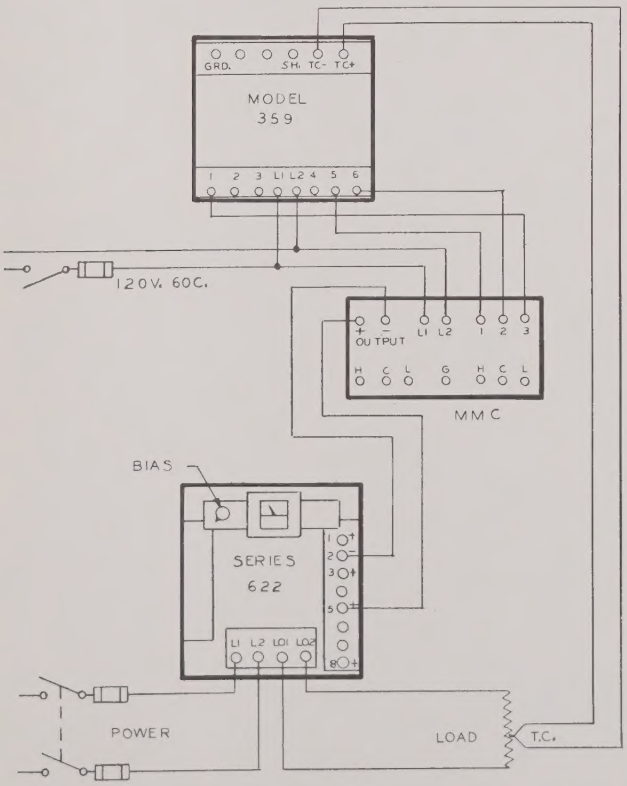


Figure 13
External Wiring Diagram
Series 622 with Model 359 Digiset and
MMC Three-Function Controller

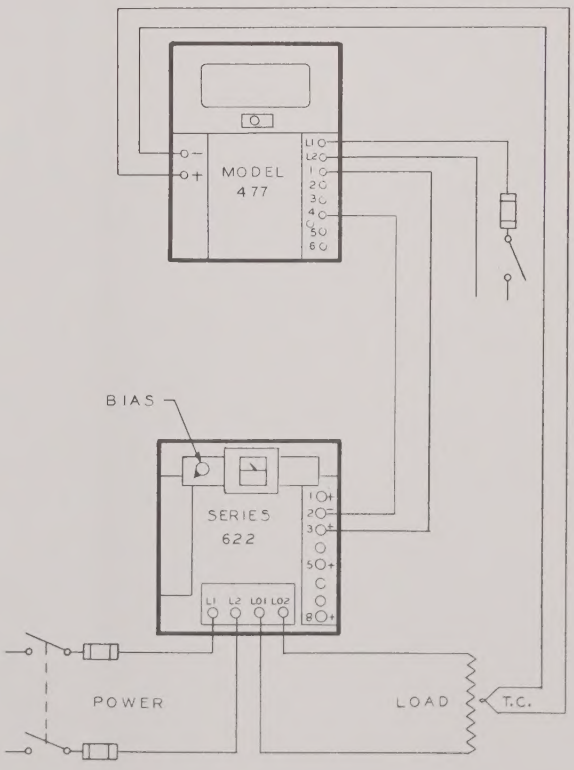


Figure 14
External Wiring Diagram
Series 622 with Model 477P Capacitrol

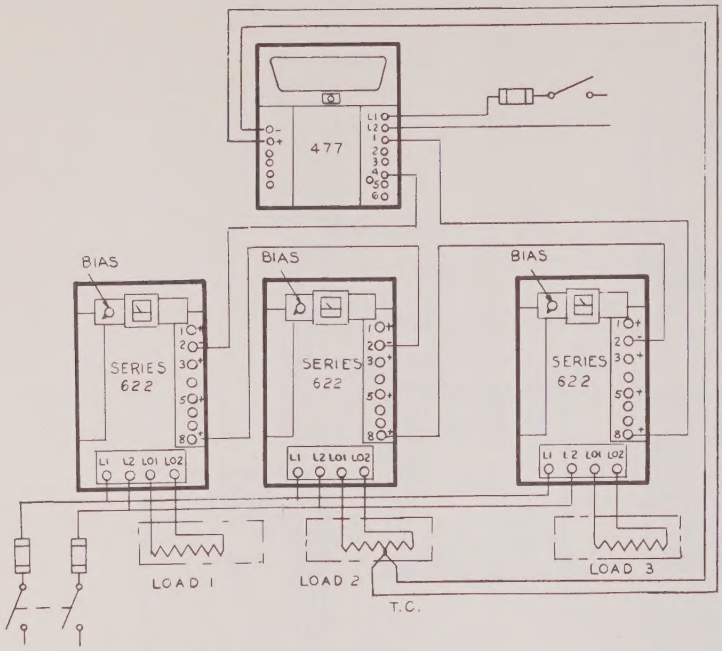


Figure 15
External Wiring Diagram
Model 477P Driving Three 622 Controllers
for Three Zone Control

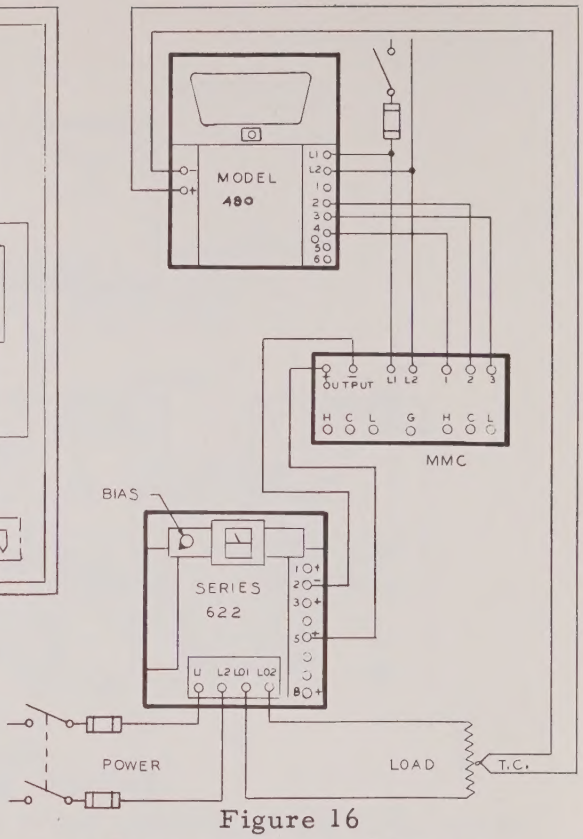


Figure 16
External Wiring Diagram
Series 622 with Model 480P Capacitrol
and MMC Three-Function Controller

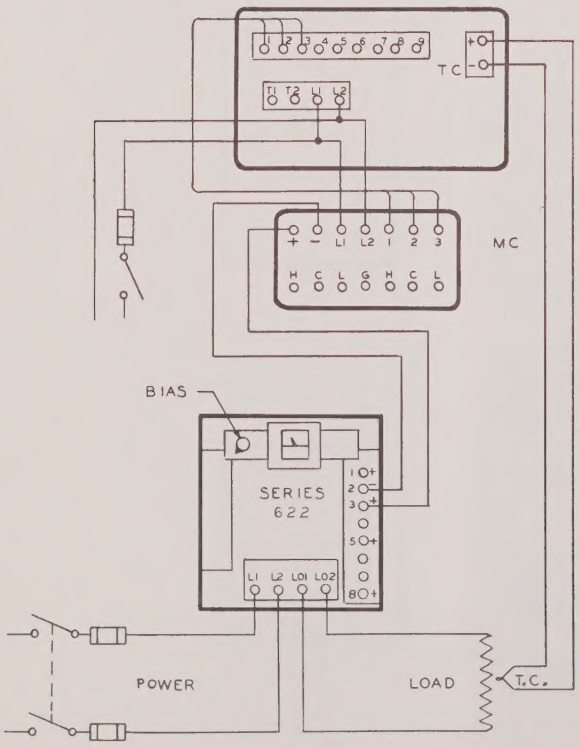


Figure 17
External Wiring Diagram
Series 622 with 2000 or 8000 Potentiometer
and MC Proportioning Controller

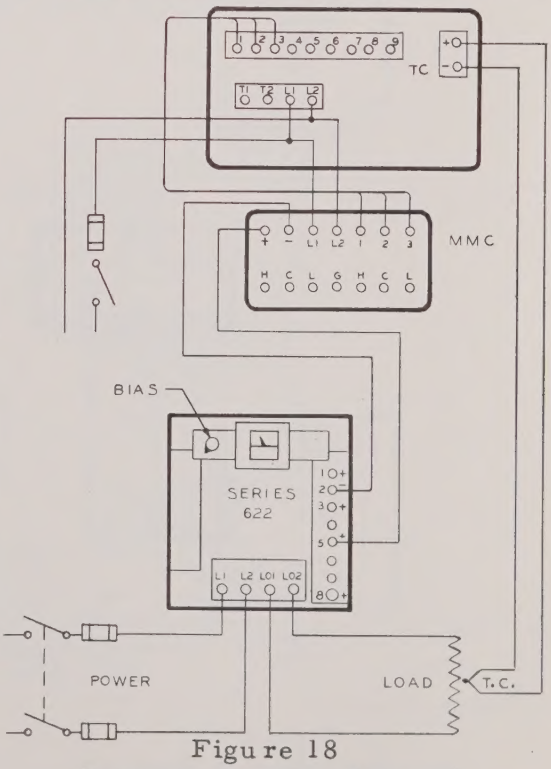


Figure 18
External Wiring Diagram
Series 622 with 2000 or 8000 Potentiometer
and MMC Three-Function Controller

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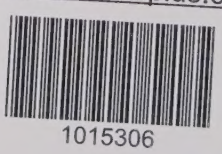

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